

REMARKS

Non-elected claims 27-34 have been canceled, and new claims 35-42 directed to the elected invention have been added. No new matter was added. Thus, claims 1, 16-26 and 35-42 are pending. Applicant submits amendments and arguments for overcoming the rejections based on the prior art of record. Accordingly, Applicant respectfully submits that the present application is in condition for allowance.

I. Claim Rejections – 35 USC §103(a)

- A. *In the non-final Office Action dated July 28, 2008, claims 1 and 16-25 are rejected under §103(a) as being obvious over JP 06-177117 A.*

(i) The Disclosure Provided by JP 06-177117 A

JP 06-177117 A is the publication of Japanese Application No. 1992-351109 filed July 12, 1992, and it has a European counterpart published as European Patent Application Publication No. 0601509 A1. Thus, EP 0601509 A1 provides a full English language translation of JP 06-177117 A (as well as JP 06-177128 A). EP 0601509 A1 has been made of record in the present application via Applicant's Information Disclosure Statement filed on January 26, 2006, which has been initialed by the Examiner. Accordingly, Applicant refers to the text of the full English language translation of EP 0601509 A1 (of record) in considering the above referenced rejection.

EP '509 (JP '117) discloses a copper alloy sputtering target having 0.02 to 20 atomic percent of Al and/or Si with the balance being copper. (For example, see page 2 of the text, lines 25-28, of EP '509 and Example Nos. 1-1, 1-2, 2-1, 2-2 and 3 on pages 4 and 5 of the text of EP '509.)

The clear stated purpose of the copper alloy sputtering target of EP '509 (JP '117) is to form, via sputtering, thin film wiring of a semiconductor device. The sputtered film forms, by itself, the actual wiring of the semiconductor device. Thus, the sputtering target of EP '509 (JP '117) is used during a sputtering operation to form wiring of a semiconductor device. This is unlike the sputtering target of the present invention which is used to form a sputtered thin film seed layer of a semiconductor device on which copper wiring is subsequently plated and grown during an electrolytic copper plating operation.

The Al, Si, or Al and Si content of EP '509 (JP '117) is for the sole purpose of forming a surface oxide layer on the thin film. The thin film wiring is formed by way of sputtering, and thereafter, is subjected to oxidation/heat treatment to cause the Al and/or Si to diffuse to the surface of the film thereby forming an outer barrier layer resistant to oxidation. For example, page 2, lines 51-53, of EP '509 states that "Thin film wirings formed on the substrate of a semiconductor device from a copper alloy containing 0.02 to 20 at% aluminum and/or 0.02 to 20 at% silicon readily form a surface oxide film upon heating at or below 500°C."

Accordingly, after the oxidation/heat treatment required by EP '509 (JP '117), the Al or Si of the thin film wiring is dispersed and concentrated only along the surface of the wiring. Thus, the Al and/or Si is/are removed from the internal bulk portion of the wiring which consists essentially of pure copper. As a result of the non-uniform presence of Al or Si in the copper wiring, the bulk internal portion of the wiring will have high conductivity (equal to that of pure copper) and the outer layer of the wiring will resist oxidation due to the high concentration of Al or Si. For example, see EP '509 on page 2, lines 53-58.

(ii) The Present Invention

The present invention is directed to a copper alloy sputtering target for forming a “seed layer” on which copper wiring of a semiconductor is plated and grown by electrolytic copper plating techniques. (The thin film having the above referenced surface barrier layer required by EP ‘509 (JP ‘117) cannot be used as a seed layer for a semiconductor device.)

Typically, a barrier film of TaN or the like is formed on an insulating film in order to prevent diffusion of copper to the interlayer insulating film. Subsequently, a thin film copper seed layer is formed on this barrier film via a sputtering process. Thereafter, a thick film copper wiring is formed by an electrolytic copper plating process. Such a plating process requires energization, thus the seed layer is required for use in turning on the electric current to enable growth of the electrolytic copper plated film. Accordingly, a seed layer is an essential layer for forming copper wiring via the electrolytic copper plating method, and the seed layer does not itself assume the role as actual wiring of the semiconductor device.

The role of the aluminum and/or silicon in the target of the present invention is clearly and significantly different from the role of the aluminum and/or silicon described in EP ‘509 (JP ‘117). One of ordinary skill in the art is taught by EP ‘509 (JP ‘117) that the Al and/or Si in the copper alloy thin film wiring can be heated to form a protective surface oxide layer while permitting the interior of the wiring to consist solely of pure copper and thereby have high conductivity. This is the only reason for the inclusion of Al or Si in the otherwise pure copper sputtering target taught by EP ‘509 (JP ‘117). The present invention is not forming wiring and an oxide layer is not desired. In fact, a surface oxide layer would render a seed layer film unusable for its intended purpose.

Accordingly, the technical concept of the present invention and the technical concept of EP '509 (JP '117) are clearly different. For at least this reason, Applicant respectfully submits that the claimed invention is neither taught nor disclosed to one of ordinary skill in the art by EP '509 (JP '117).

In the Office Action, it is stated that:

“With respect to the instant claimed optional elements and impurities that have the contents read on zero; thus, cited references does not have to disclose those elements”

In direct response to the above statement, Applicant has amended the claims of the present application. The copper alloy sputtering target of claim 1 of the present application has been amended to require the total amount of “Mn or Si or both” to be 0.03wtppm to 0.25wtppm. No new matter was added. For example, the combination of Mn and Si content in Example 6 of the present invention disclosed on page 11, Table 1, of the present application, as filed, is 0.03wtppm.

In addition, claim 1 of the present application has been amended to include the limitation formerly recited in claim 19. For example, claim 1, as amended, requires the copper alloy sputtering target to affirmatively contain at least one element selected from the group consisting of Sb, Zr, Ti, Cr, Ag, Au, Cd, In and As in a stated total amount.

Dependent claims 19-21 of the present application have also been amended and recite limitations with respect to the total amount required by claim 1 with respect to the at least one element selected from the group consisting of Sb, Zr, Ti, Cr, Ag, Au, Cd, In and As. Claim 19 has been amended to include a lower limit of the total amount. The lower limit is 0.13wtppm. No new matter was added. For example, the total content of these elements for Example 1 of the

present invention disclosed on page 11, Table 1, of the present application, as filed, is 0.13wtppm. Claims 20 and 21 provide further limits to the upper limit of this content.

New independent claim 35 includes the limitations of claim 1 and claim 19, discussed above. New independent claim 35 differs from claim 1 in that claim 35 recites close-ended “consisting of” terminology as compared to the open-ended “containing” language of claim 1.

New independent claim 39 is substantially identical to claim 35, except claim 39 specifically requires “Sn” instead of “at least one element selected from Al and Sn”.

New dependent claims 36 and 40 limit the “at least one of Mn or Si or both” specifically to “Mn”. New dependent claims 37, 38, 41 and 42 recite subject matter disclosed by claims 16, 21 and 26.

(iii) Reasons for Patentability

EP ‘509 (JP ‘117) discloses a copper alloy sputtering target including 0.02 to 20 at% Al and/or Si with the balance being copper. No other elements are included, and the sole purpose of the Al and/or Si is for being diffused to the surface of sputtered thin film wiring as a result of heat treatment to form a protective, oxidation-resistant, surface oxide layer about a core of pure copper of high conductivity.

Claim 1, as amended, of the present application requires the copper alloy sputtering target to include Al and/or Sn of a stated content, Mn and/or Si of a stated content, and a stated amount of at least one element selected from the group consisting of Sb, Zr, Ti, Cr, Ag, Au, Cd, In and As. Also, see dependent claim 19, as amended, which requires a lower limit of the at least one element selected from the group consisting of Sb, Zr, Ti, Cr, Ag, Au, Cd, In and As.

Page 6, lines 21-30, the present application, as filed, states the reason for the presence of Sb, Zr, Ti, Cr, Ag, Au, Cd, In and/or As in the sputtering target, and hence thin film seed layer, of the present invention. This presence is not as an impurity; rather, the presence of this/these element/elements in the stated amount is desired because it improves oxidation resistance without increasing sheet resistance and without deteriorating the coagulation prevention function desired of the seed layer. Thus, Applicant respectfully submits that the amendments of claims 1 and 19 clearly distinguish claims 1 and 19 over EP '509 (JP '117).

New claims 35, 36, 39 and 40 provide additional limitations that distinguish over EP '509 (JP '117). Independent claim 35 includes all the limitations of claims 1 and 19 and in addition uses close-ended "consisting of" terminology. Independent claim 39 also uses close-ended "consisting of" terminology and affirmatively requires a stated amount of Sn content. EP '509 (JP '117) requires only Cu plus Al and/or Si content, and thus, requires no Sn content. Claims 26 and 40 affirmatively require a stated amount of Mn content. As stated above, EP '509 (JP '117) requires only Cu plus Al and/or Si content, and thus, requires no Mn content. Accordingly, Applicant respectfully submits that claims 35, 36, 39 and 40 also clearly distinguish over EP '509 (JP '117).

In addition to the claim amendments, Applicant respectfully submits that one of ordinary skill in the art is provided with no common sense reason for modifying the copper alloy sputtering target of EP '509 (JP '117). The end result desired and taught by EP '509 (JP '117) is pure copper wiring having high conductivity. Al and/or Si are present only for the purpose of being diffused to the outer surface of the film to form a surface oxide layer that protects the pure copper on the interior of the thin film. Thus, the presence of any other element would be

considered an impurity and attempts would be made to limit or eliminate their existence, not ensure a stated amount of their presence.

Accordingly, Applicant respectfully submits that EP '509 (JP '117) teaches away from the copper alloy sputtering target required by the claims of the present invention. In addition, the presence of additional elements in the sputtering target and thin film of EP '509 (JP '117) would destroy or greatly reduce the desired outcome of EP '509 (JP '117) which is to provide a sputtered thin film wiring of a semiconductor that has a substantially pure copper interior providing conductivity equal to that of pure copper.

EP '509 (JP '117) provides a copper wiring layer that must be able to prevent an increase of wiring resistance caused by the miniaturization of the wiring as well as electro migration (EM) and stress migration (SM). These are of no concern with respect to the present invention. Rather, the copper seed layer of the present invention must be able to effectively prevent coagulation during plating and must provide improved wettability with the barrier film. Further, in order to facilitate energization during electrolytic copper plating, the present invention is required to maintain low sheet resistance. One of skill in the art is simply not taught how to provide a sputtering target having these characteristics by EP '509 (JP '117).

For all the reasons stated above, Applicant respectfully submits that the sputtering target required by claims 1 and 16-25 (as well as new claims 35-42) would not be obvious to one of ordinary skill in the art based on the teachings of EP '509 (JP '117). Applicant respectfully submits that the claims of the present application are patentable over EP '509 (JP '117) and respectfully request reconsideration and removal of the rejection.

- B. In the non-final Office Action dated July 28, 2008, claim 26 is rejected under §103(a) as being obvious over JP 06-177117 A in view of U.S. Patent No. 6,113,761 issued to Kardokus et al.*

JP 06-177117 A and its deficiencies relative to the claims, as amended, of the present application are discussed above in detail. The Kardokus et al. patent fails to overcome any of these deficiencies. Accordingly, for the same reasons discussed above, Applicant respectfully submits that claim 26 of the present application is not obvious and is patentable over JP '117 in view of the Kardokus patent.

II. Co-Pending U.S. Applications

Out of an abundance of care, Applicant's undersigned attorney brings the following co-pending, commonly-owned U.S. patent applications to the Examiner's attention for purposes of consideration of double patenting issues. Co-pending U.S. Patent Application Nos. 10/530,438 and 10/501,117 are owned by the Assignee of the present application, include T. Okabe as a named inventor, and are being prosecuted by Examiner Sikyin Ip of the U.S. Patent and Trademark Office. Both applications are directed to copper alloy sputtering targets that contain stated amounts of Al and that are used to form seed layers of semiconductor devices.

Applicant's Information Disclosure Statement filed on January 26, 2006 cited the U.S. Patent Application Publications for each of these co-pending applications (namely, U.S. Patent Application Publication Nos. 2005/0285273 A1 and 2005/0121320 A1). These entries have been initialed by the Examiner.

The Examiner has indicated the possibility of allowable subject matter (claims 30-36) in a FINAL Office Action dated October 30, 2008 for U.S. Patent Application No. 10/530,438, and

Applicant has recently filed an Amendment on October 27, 2008 for U.S. Patent Application No. 10/501,117 in which no claims are currently indicated as being allowed.

Finally, Applicant files a Supplemental Information Disclosure Statement with this Amendment to bring any of the prior art references of record in the above referenced co-pending applications that have not yet been made of record in the present application.

III. Conclusion

In view of the above amendments and remarks, Applicant respectfully submits that the rejection has been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

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